

STUDIES OF NORTH AMERICAN *ERORA* (SCUDDER)
(LEPIDOPTERA, LYCAENIDAE)

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Abstract.—The genus *Erora* Scudder is characterized and discussed. Characteristics of *E. laeta* (Edwards), *E. quaderna quaderna* (Hewitson) and *E. quaderna sanfordi* dos Passos are given and evaluated. The early stages, ethology, ecology and geographic distributions of *E. laeta* and *E. quaderna sanfordi* are described. The peculiar dense vestiture of the larvae, and a “bald” area (the calvarium) on the prothorax, are potentially significant in generic taxonomy. Full, annotated synonymies and lists of distributional records are given. Possible phylogenies are discussed.

Introduction

For many years the authors pursued studies of the North American *Erora*, first of *E. laeta* and more recently of *E. quaderna sanfordi*. The work has consisted of three main parts: field studies of the life histories, ecology and ethology; compilations of records and data from museum specimens, the published literature and personal communications; and comparative taxonomic studies. This article deals with these taxa in North America north of Mexico; but it also contains some notes and comments on the still little-known *E. q. quaderna* and *E. caudata* Miller in Mexico.

Acknowledgments

We are greatly indebted to many persons for information and assistance. From John H. Cook, A. C. Frederick and James Sanford we learned about the two localities in Vermont where most of our eastern field studies were made. The late Sidney Hessel furnished notes and records, and generously refrained from collecting in the areas where we were doing life-history work. (What greater sacrifice can a devoted collector make?) Joseph J. Copeland checked many plant identifications. T. G. Howarth of the British Museum (Natural History) picked out and dissected for our study the types of *E. attalion* (Godman and Salvin), *E. quaderna* (Hewitson) and possibly related species. W. D. Field of the U.S. National Museum gave us many data about genitalic structures and neotropical species. Harry Clench of the Carnegie

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Museum very kindly gave us transcripts of his and Lee D. Miller's field data on *E. quaderna* in Mexico, and data on the differentiation of *E. q. quaderna* and *E. q. sanfordi*. A. C. Allyn, Director and Lee D. Miller, Curator, of the Allyn Museum of Entomology gave us very valuable photographic aid and sent us some needed data. Vincent Roth and Kilian Roever gave much helpful advice at the Southwestern Research Station of the American Museum of Natural History near Portal, Arizona, where *E. q. sanfordi* was studied. Numerous other individuals who have collected *E. laeta* very kindly answered our queries about the circumstances, or looked up specimens and records in collections.

Erora Scudder, 1872

4th Ann. Rept. Peabody Acad. Sci., 1871:53

Type species by original designation: *Thecla laeta* Edwards; includes also *T. clothilde* Edwards, Proc. Acad. Nat. Sci. Philadelphia, 1862 (14):55.

Erora Scudder, 1872, p. 169.

Erora Scudder, 1875, 10:166.

Erora Scudder, 1876, p. 106.

Erora Scudder, 1889, 2:815.

Erora Scudder, Dyar, "1902" [1903], p. 40.

Erora Scudder, Barnes and Benjamin, 1926, p. 18.

Erora Scudder, McDunnough, 1938, p. 25.

Erora Scudder, Procter, 1938, p. 186.

Erora Scudder, Field, 1941, p. 303.

Erora Scudder, dos Passos, 1964, p. 55.

Erora Scudder, Hemming, 1967, p. 169.

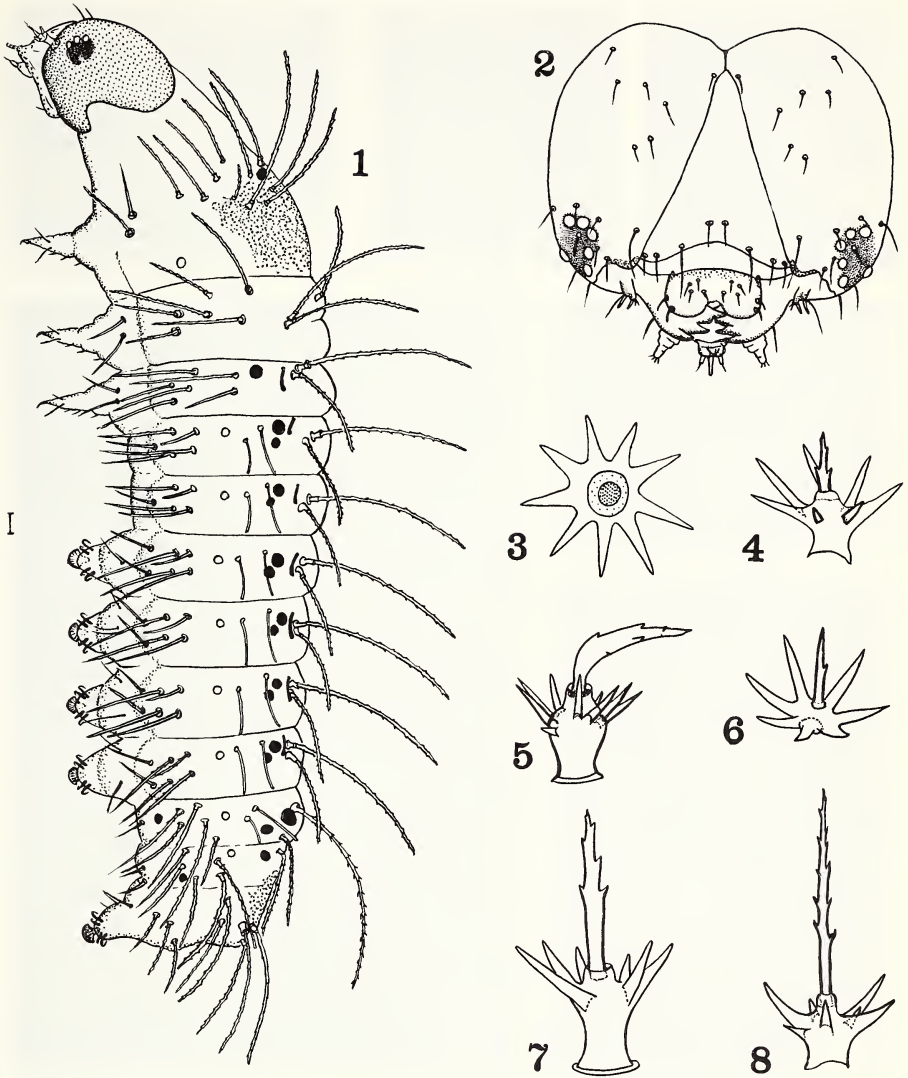
Erora Scudder, dos Passos, 1970, p. 35.

Erora Scudder, Miller, 1980, p. 209.

Field (1941) added *Thecla quaderna* Hewitson, 1868 to *Erora* so that the genus consisted of two species, *laeta* and *quaderna*; in 1980 Miller added *E. caudata*.

Scudder's original description of *Erora* read as follows: "Lower Canada to Virginia. Head moderately large; front as broad as the eyes on a front view and scarcely half as high again as broad; eyes thinly pilose; palpi slender, but little longer than the eye. Fore tibiae about four-fifths the length of the hind tibiae; middle and hind tibiae of about equal length; first superior branch of the subcostal nervure [R_1] arising, at least in the female, a very little beyond the middle of the upper border of the cell; the second [R_2] about midway between this and apex, cell slightly more than half as long as the wing."

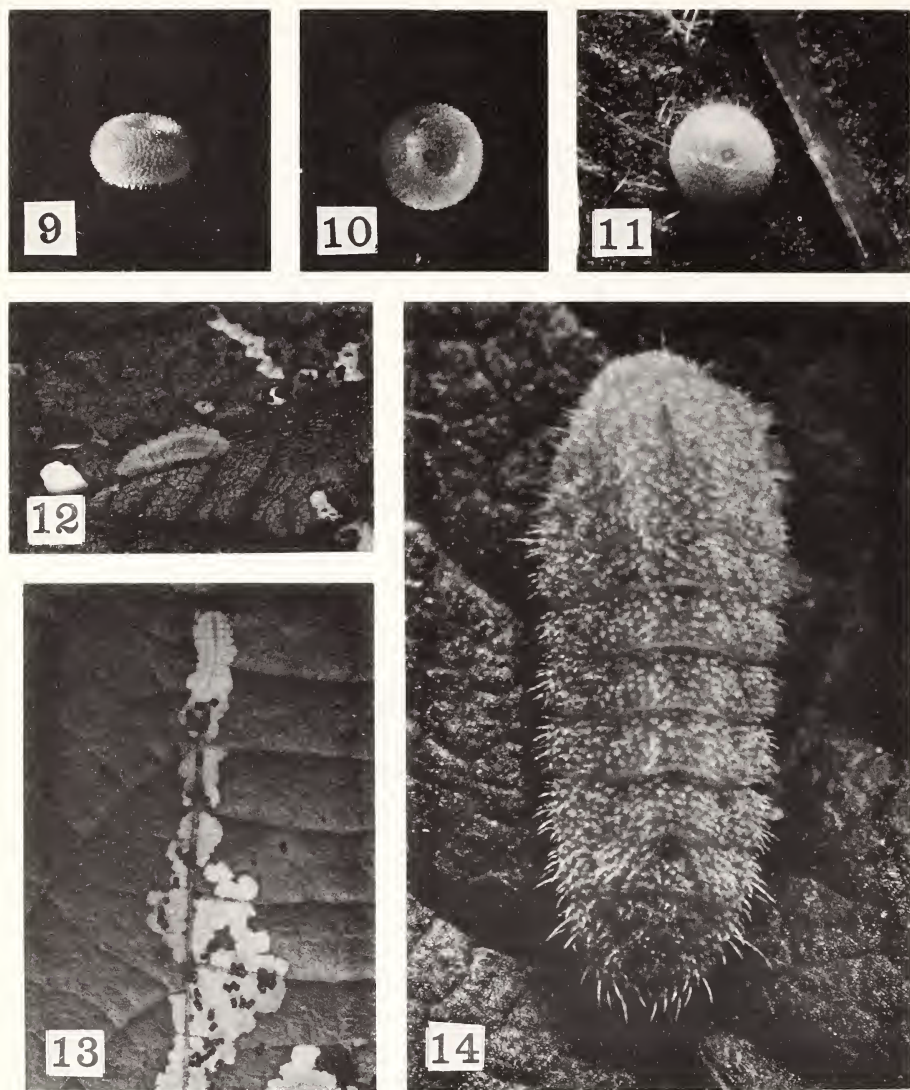
To Scudder's original characterization we add the following, based on



Figs. 1-8. *Erora laeta*. 1. 1st instar larva, left lateral view. 2. 2nd instar larva, cephalic view, head. 3-8. 5th instar larvae, coronate chalazae.

both *laeta* and *quaderna*, and on the characters given by Miller for *caudata*. Very likely some of the characters cited will prove of secondary importance when more is known about the neotropical Theclini.

Male wings lacking stigma or scent pad: Both sexes of *laeta* and *quaderna* with outer margin of hindwing even, with no tails, anal projections or lobes;



Figs. 9-14. *Erora laeta*. 9. Egg, lateral view. 10. Same egg, terminal view. 11. A different egg, terminal view. 12. 2nd instar larva, lateral view. 13. The same larva, dorsal view, showing characteristic skeletonizing of leaf. 14. 3rd instar larva, dorsal view, disproportionately greatly enlarged.

caudata with a short tail at CU_2 . Wings deep fuscous above with some iridescent blue in male, much more in female. Hindwings and at least apical area of forewings beneath pigmented green with transverse rows of spots; these, and to some degree fringes, orange to orange-red.

Male genitalia with labides broad and rounded: A longitudinal sclerotized strip in fultura superior. Falces strongly curved and pointed, wholly well separated from each other. Tegumen with no processes from ventro-caudal angle. Valvae well separated from each other, broad basally, terminally bent strongly dorsad and pointed, terminal margins not toothed. Aedeagus long and thick, its basal opening nearly half the length of the penis; penis with a short terminal spine. Cornutus normally well basad in penis, thick, basally blunt, tapering to a point, about $\frac{1}{3}$ the length of penis.

Female genitalia with papillae anales long, slender, setose: A single pair of apophyses (apophyses posteriores) bluntly angled or curved ventrad, caudad of middle. Ostium bursae well sclerotized, flat, its dorsal wall (lamella postvaginalis) split and extending farther caudad than its ventral wall (lamella antevaginalis), subterminally widened and then tapering caudad to a blunt, rounded end. Ductus bursae short, wide, containing a well sclerotized, doubled structure with a median series of short, transverse grooves; ductus seminalis coming off dorso-caudally from this, bending laterad. Bursa copulatrix elongate, with a pair of sclerotized signa, each an oval plate with a longitudinal, projecting keel tapering gradually cephalad to a fine, single or double point. Field (1951) gives excellent figures of the genitalia of *laeta* and *quaderna*, and Miller (1980) of *caudata*, which we do not think it necessary to duplicate.

Egg (*laeta* only, Figs. 9–11): Not strongly flattened, laterally rounded, with a great many short, very fine, conical projections arising from the junctions of very fine, raised ridges.

Larva, mature (*laeta* and *sanfordi*): Light greenish, patterned with dark reddish spots (*laeta*) or unmarked (*sanfordi*). Very thickly covered with various sizes of coronate chalazae, each bearing a single terminal, very finely spiculate seta (Figs. 3–8). Prothorax with a median dorsal, diamond-shaped, or scutelliform, area of very minute vestiture which we term a "calvarium" (Latin—*calvus*, bald). Prominent dorsolateral and ventrolateral ridges, the areas between these slightly concave. Swellings in each segment along dorsolateral ridges give the larva a somewhat serrate aspect in lateral profile. A pair of more prominent swellings on mesothorax. No honey gland or associated tubercles. No silk girdle seen (three larvae pupated in captivity): cremasteral pads and bristles normal.

Pupa (two of *laeta*, one of *sanfordi*): Short, rounded, with darker and lighter areas caused by the relative amount of sclerotization in the irregular meshwork of ridges. Vestiture sparse, of single, minutely spiculate setae; no complex projecting chalazae. Stridulatory organ with the grating surface heavily sclerotized, of many short, fine, parallel, almost uniform ridges.

Foodplants: Fagaceae (*Fagus* and *Quercus*) as far as known; perhaps also Corylaceae (*Corylus*).

Phylogeny: For phylogenetic speculations we are concerned here with

only *laeta* and *sanfordi*, omitting *caudata*. Obviously *laeta* and *sanfordi* are very closely related to each other, yet the wide separation of their geographic ranges presents something of a problem. *E. laeta* occurs from southern Canada southward to Virginia, Tennessee, Kentucky and Georgia along the Appalachian highlands. If considered alone it might well be judged a species of Nearctic origin with southward extensions along the mountains, as is the case with many northern species. *E. quaderna quaderna*, on the other hand, occurs from south-central Mexico southward to Guatemala and Costa Rica, but has an isolated subspecies (*sanfordi*) in the southern Rocky Mountains and northern Mexico. This distribution is characteristic of many neotropical species. Attempting to reconcile the close relationship of the two species with their very different distributions, we see two possibilities:

(1). *Erora* may have evolved as an oak-feeding *quaderna*-like stock in the central or southern Mexican highlands. Then, as a Pleistocene glaciation (probably the Wisconsin) pushed the biota southward, the northern beech-birch-maple forest reached this region. Most of the *quaderna*-like population would be forced farther southward along the Central American Cordillera; but some of it, lagging behind, became adapted to a beech-feeding life in the deciduous (and less xeric) forest, and evolved changes that led to *laeta*. Then as the glaciation subsided this differentiating *laeta* accompanied the boreal forest northward to its present northern range. Meanwhile, the southern *quaderna*-like stock evolved into the present *quaderna* (and perhaps other species) and moved northward in Mexico again, and along the Sierra Madre Occidental (and perhaps the Sierra Madre Oriental) into the southern Rocky Mountains of New Mexico and Arizona along with the "live-oaks." After this, we know, followed a period of climatic desiccation (which still continues) that formed the Sonoran and Chihuahuan deserts. This pinched off the northern population, which evolved into *E. quaderna sanfordi*, separated by desert from *E. q. quaderna* and by the arid Great Plains from *E. laeta*.

(2). A second possibility is that *Erora* may have originally evolved as a *laeta*-like stock in the northern deciduous forest. During the Wisconsin glaciation this would have been pushed far southward into Mexico. On the recession of the glacier this population would have returned northward as *laeta*. Left behind in Mexico were populations that evolved there into the live-oak feeding *quaderna*; and from these, as postulated above, evolved the northern isolate, *E. quaderna sanfordi*.

We consider the first of these alternatives to be the more likely, chiefly because of the existence in Mexico and southward of other species (e.g. *E. caudata* Miller) very similar to, and possibly congeneric with, *quaderna*; and also because of the differentiation of *quaderna* into two subspecies, while the more recently evolved *laeta* has remained homogeneous. Cer-

tainly a great deal more fieldwork and collecting is needed along the Sierra Madre Occidental, Sierra Madre Oriental and Sierra Madre Transversal, and also southward along the highlands of Central America, to learn both more about *quaderna* itself, and also more about the possible other *Erora* and *Erora*-like species in this region. *E. caudata* was named "from cloud forest," and there may be yet-undescribed species in this environment; while undescribed species of a *quaderna* stock may exist in the more xeric highlands of southern Mexico and southward.

Erora laeta (Edwards) ♂, 1862

Erora clothilde (Edwards) ♀, 1863

Thecla laeta Edwards, 1863, [14] (4):55 (London, [Ontario], leg. W. Saunders) (our figures 21–22).

Thecla clothilde Edwards, 1863, 2(1):15 (Quebec, C. E., leg. Rev. M. Provancher).

Thecla laeta Edwards, Weidemeyer, "1863" [1864], 2(2):534 (British N[orth] A[merica]).

Thecla clothilde Edwards, Scudder, 1868, 11(24):377 (Streaked Mountain, near Paris, Maine, July 22, leg. Smith).

Thecla laeta Edwards, Scudder, 1868, 11(24):377 (Streaked Mountain, near Paris, Maine, July 22, leg. Smith).

Thecla laeta Edwards, "1868–72" [1869], 1(3):[139], pl. *Thecla* 1, figs. 1, 2 ♂, 3, 4 ♀ (London, [Ontario] Canada, leg. Saunders, 1861; Coalburgh, Kanawha Co., West Virginia, April 1868; Paris, Maine, July 22, leg. W. Saunders).

T[hecla] laeta Edwards, Kirby, 1871, p. 401, no. 371 (Amer. Sept.).

T[hecla] clothilde Edwards, Kirby, 1871, p. 401, no. 371 (Amer. Sept.).

Erora laeta (Edwards) (= *Thecla clothilde* Edwards), Scudder, 1872, p. 32 (lower Canada to Virginia).

Erora Scudder (1872) *laeta* (Edwards) (= *clothilde*) (Edwards), Scudder, 1876, 3(13):106, no. 203 (Ontario, Quebec and Maine [along the Appalachians?] to West Virginia).

Thecla laeta Edwards (= *clothilde* Edwards), 1877, p. 42, no. 327 (Maine to West Virginia, Ontario, Quebec).

Thecla laeta Edwards (= ♀ *Thecla clothilde* Edwards), Strecker 1878, p. 90, no. 108 (Canada, Atlantic states, Maine to Virginia).

Thecla laeta Edwards, Anon., 1881, p. 3, no. 358.

Thecla laeta Mead, 1882, 2(1):18 (Coalburgh, West Virginia, July 1881, leg. Theodore L. Mead).

Thecla laeta Edwards, Edwards (*partim*), 1883, 3(1):8 (Pr. Quebec, Ontario, Maine, Catskills, New York; White Sulphur, Coalburgh, West Virginia).

- Thecla laeta*, 1883, 3(9):123 (Coalburgh, West Virginia, April 17, 1883).
T[hecla] laeta Aaron, 1884, 4(1):22 (Sand Hills below Atlantic City, New Jersey, 1 July [1883]).
Thecla laeta Edwards, Fernald, 1884, p. 83, no. 45 (Orono, 18 May).
Thecla laeta Edwards (= ♀ *clothilde* Edwards), Edwards (*partim*), 1884, p. 299, no. 374 (Maine to West Virginia; Atlantic City, New Jersey; Ontario, Quebec).
Thecla laeta Edwards (*partim*), 1884, p. [336] (Quebec, Ontario, Maine, New York, West Virginia).
Thecla laeta Maynard, 1886, p. 37, no. 47 (Canada, Maine, West Virginia).
Thecla laeta Edwards, French (*partim*), 1886, p. 277, no. 114 (Atlantic City, New Jersey; Maine to West Virginia).
Erora laeta Scudder (*partim*), 1889, 2:819, 3: Pl. 14, figs. 6, 9; Pl. 23, fig. 2; Pl. 39, fig. 17; Pl. 55, fig. 2; Pl. 65, fig. 8 (St. Joachim 25 mi from Quebec, leg. Bowles; London, Ontario, leg. Saunders; Catskills, New York, leg. Edwards; Atlantic City, New Jersey, leg. Aaron; Coalburgh, Kanawha Co., West Virginia, leg. Edwards; Streaked Mt. near Paris, leg. Smith; Orono, Maine, leg. Fernald; Graylock Hopper, Williamstown, Massachusetts, leg. Scudder).
Thecla laeta Edwards, Winn, 1891, 23(5):96 (Beloeil Mt. 22 mi east Montreal, May 24, 1888, leg. Albert F. Winn).
Thecla laeta Edwards, Maynard (*partim*), 1891, p. 37, no. 47 (Atlantic City, New Jersey).
Thecla laeta Edwards, Smith et al., 1891, p. 12, no. 296.
Thecla laeta, Maynard, 1891, p. 37, no. 47 (Canada, Maine, West Virginia).
Thecla laeta Edwards, Fyles, 1893, p. 31 (Beloeil Mt., [Quebec] May, leg. Albert F. Winn).
Thecla laeta, Scudder, 1893, p. 123 ("widely distant places").
Thecla laeta Edwards (*Erora laeta*), Bethune, 1894, p. 36, no. 56 (London and York Mills, Ontario, Beloeil Mt., St. Joachim, St. Hilaire and Quebec, May).
Thecla laeta Edwards, Fyles, 1897, p. 12 (Sherbrook, May 25, 1895, leg. Rev. Abbe Begin).
Thecla laeta Edwards (= ♀ *clothilde* Edwards), Skinner (*partim*) 1898, p. 50, no. 306 (Maine to West Virginia; Ontario, Quebec).
Thecla laeta Edwards, Holland (*partim*), 1898, p. 249, (36) pl. 29, figs. 23 ♂, 24 ♂ (Quebec to southern New Jersey westward to West Virginia).
Thecla laeta, Grant, 1898, p. 76 (cedar swamp on cedar bush near Orillia [Ontario], May 12, leg. James Walker).
Thecla laeta Edwards, Skinner, (*partim*), 1898, Synonymic Cat. N.A. Rhop., p. 50, no. 306 (Atlantic City, New Jersey).
Thecla laeta Edwards, Weed and Fiske, 1901, p. 47 (New Hampshire).

- Thecla laeta* Edwards, Smith et al., 1903, p. 7, no. 325.
- Erora laeta* (Edwards) (= *clothilde* Edwards), Dyar, "1902" [1903], p. 40, no. 383 (Montana, Colorado).
- Thecla laeta*, Young, 1904, p. 19 (Ottawa District, leg. C. H. Young).
- Erora laeta* (Edwards), Fletcher et al., 1904, p. 91, no. 383 (Meach Lake, Quebec, May 18, leg. C. H. Young).
- Thecla laeta* Edwards, Wright (*partim*), 1905, p. 62 (E[astern] states N[ew] J[ersey], Canada to Ariz[ona]).
- Thecla laeta* Edwards, Skinner, [1905], p. 18 (Maine to West Virginia; Ontario, Quebec).
- Erora laeta* (Edwards), Stevenson, 1905, p. 54 (St. Hilaire, Quebec, May 24, leg. E. C. Barwick).
- Erora laeta* (Edwards), Elrod (*partim*), 1906, p. 131 (?Montana and Colorado *fide* Dyar).
- T[hecla] laeta*, Fletcher, 1906, pp. 27, 92, no. 383 (Digby, [Nova Scotia] leg. John Russell).
- Erora laeta* (Edwards), Fletcher and Gibson, 1907, p. 119, no. 383 (Meach Lake, Quebec, June 14, 15, leg. C. H. Young).
- T[hecla] laeta* Edwards, Coolidge (*partim*), 1910, p. 374 (Quebec, S to West Virginia and W to Montana, then S to Sonora).
- Erora laeta* (Edwards), Perrin and Russell, 1912, 12:262 (Mt. Beaman, Digby, June 19, 1905, June 7, 1906, leg. Ben Lemond).
- Thecla laeta* Edwards, Winn, 1912, p. 15 (Quebec, leg. G. J. Bowles; St. Joachim, May, leg. T. W. Fyles; St. Hilaire, May, leg. Albert F. Winn; Lost River, May, leg. Lachlan Gibb; Meach Lake, leg. Charles H. Young).
- Erora Scudder laeta* (Edwards) (= ♀ *clothilde* Edwards), Barnes and McDunnough, 1917, p. 15, no. 393.
- T[hecla] laeta* Edwards (*partim*) (= ♀ *clothilde* Edwards), Draudt in Seitz, "1924" 1907-1924 (1920), 5:783, pl. 1044, *ibid.* 1924, pl. 1044 (eastern United States).
- Erora laeta* (Edwards), Criddle, 1922, p. 58, no. 393 (16 Island Lake, Quebec, May 18, leg. Miss Ina B. Muir) [Argenteuil Co., May 19 or 20].
- Erora laeta* (Edwards), Mousley, 1923, 55(2):26 (Hatley, Quebec, Mt. Orford, 2860, April 30, May 21, 1922 [beech]).
- Erora laeta*, Mousley, 1926, 58(12):293 (Quebec, April 1921 [beech] [ovum on *Fagus*]).
- Erora Scudder laeta* (Edwards) (= ♀ *clothilde* [Edwards]), Barnes and Benjamin, 1926, 25(1):18, no. 398.
- E[rora] laeta* (Edwards), Forbes in Leonard, 1928, p. 680, no. 393 (Keene Valley, Not[man]; Cortland, Wickwire, leg. Angle; Ithaca, leg. Eyer—CU; Catskill, New York, May, June, leg. Edwards).

- Thecla* (*Erora* Scudder) *laeta* (Edwards), Holland (*partim*), 1931, p. 239, no. (55), pl. 29, figs. 23 ♂, 24 ♂ underside (Quebec to southern New Jersey westward to West Virginia).
- Erora laeta* (Edwards), dos Passos and Grey, 1934, 66(8):191 (Paris, leg. Scudder; Lincoln, leg. Clayton; Mt. Desert, leg. Mrs. A. E. Brower; Maine [beech]).
- E[rora] laeta* (Edwards), Procter, "1937" [1938], p. 186 (418) (Bar Harbor, May 19, leg. Br[ower]).
- T[hecla] laeta* Edwards, Davenport and Dethier, "1937" [1938], 17(4):173 (ova, larva, food plant *Fagus*).
- Erora* Scudder *laeta* (Edwards (= ♀ *clothilde* Edwards), McDunnough, 1938, p. 25, no. 418).
- Erora laeta* (Edwards), Comstock (*partim*); 1940, 48(1):83, (Atlantic City, New Jersey, July 1, leg. Aa[ron], 2 broods, Pennsylvania, New York, New England states, eastern Canada).
- Erora laeta* (Edwards), Field, 1941, 34(2):309–311, pl. 1, fig. 1; pl. 2, figs. 1–4; pl. 3, figs. 9 and 10 (Atlantic City and Cape May, New Jersey *fide* Murray-Aaron; Huntington, West Virginia; Mt. Equinox, Manchester, Vermont, 1935; Mt. Killington, Vermont, 1937; Little River, Great Smoky Mts., Nat. Park, Tennessee, April 15, 1938, leg. Arthur Stupka; Mt. Washington, New Hampshire, leg. L. W. Sweat; London, Ontario; City of Quebec, St. Joachim, St. Hilaire, Sherbrooke, Meach Lake, 16 Island Lake, Hatley, Mt. Orford, Quebec; Digby, Nova Scotia; Paris, Bar Harbor, Lincoln, Orono, Norway, Maine; Catskill Mts., Keene Valley, Cortland, Ithaca, New York; Atlantic City, Cape May, New Jersey; Williamstown, Massachusetts; Coalburgh, West Virginia; White Sulphur, Huntington, Virginia).
- Erora laeta* (Edwards), Clench, 1943, 51(3):223 (Lake St. Joseph, Portneuf Co., Quebec, June 1932, leg. G. B. Fairchild).
- Erora laeta* Remington and Clench, 1947, 1(4):42 (Great Smoky Mts., North Carolina and Tennessee).
- Erora laeta*, Carl Cook, 1948, 2(2):22 (Crailhope, Kentucky, April 1941, May 6, 1947).
- Erora laeta* (Edwards), Klots, 1951, pp. 16, 24, pl. 16, fig. 14, pp. 129, 142 (eastern Canada, New England south to Kentucky, chiefly Canad. Zone Forest).
- Erora laeta* (Edwards), Clark and Clark, 1951, 15:85 frontispiece, fig. 8; pl. 12, a. b. (Mt. Lakes Biol. Stat., Giles Co., Virginia, June 23, 1938, leg. Lorus J. Milne).
- Erora laeta* (Edwards), Hessel, 1952, 6(1–3):34 (Cragway Spring, Mt. Washington Toll Road, New Hampshire, 4,660').
- E[rora] laeta* (Edwards), Ferguson, 1954, 23(3):197 (Mt. Beaman, leg. John

- Russell; June 19, 1905; June 2, 1908; June 7, 1906; near Digby, June 16, 1931; Armdale, May 14, 1944, leg. D. C. Ferguson).
- Erora laeta* (Edwards), Voss and Wagner, 1956, 10(1-2):20, fig. 1, 5th row; 21 (Bliss Township, Emmet Co., Michigan, May 14, 1955).
- Erora laeta* (Edwards), Lycaenidae, Clench, "1956" [1957], 10(5):161, (Powdermill Nature Reserve, 4 mi south Rector, eastern Westmoreland Co., Pennsylvania, May 3, 1956).
- Erora laeta*, Clench, 1958, p. 7 (Calverley Lodge, Powdermill Nature Reserve, Pennsylvania, May 3, 1956, leg. H. K. Clench).
- T[hecla] laeta* Edwards, Forbes, 1960, p. 131, pl. 1, fig. c (northeastern states west to Michigan, mts. of Tennessee).
- Erora laeta* Edwards, Moore, 1960, p. 17 (Bliss Township, Emmet Co., Michigan, May 14, 1955).
- Erora laeta* Edwards, Dunlop, 1960 (Algonquin Provincial Park, May 20, 1960; June 19, 1960; *Fagus* present in both places); (also records specimen in Royal Ontario Museum, Orillia, Ontario, leg. J. Walker).
- Erora laeta* (Edwards), Clench in Ehrlich and Ehrlich, [1961], p. 218, fig. 419 (Bear Mt., Vermont; south Nova Scotia, south Quebec to Appalachians to Tennessee, west to north Michigan, south-central Kentucky).
- Erora laeta* (Edwards), Smith, "1960" [1961], 14(4):239 (Benton Twp., Grafton Co., New Hampshire 1,800', June 7, 1960).
- Erora laeta* (Edwards), Riotte, 1961, 15(2):92 (Algonquin Park, Ontario, May 20, 1960).
- Erora laeta* (Edwards), Roever (*partim*), 1962, 16(1):1, 4 (Ontario and Nova Scotia south to Virginia, ♀ Little River, Great Smoky Mts. Nat. Park, Sevier Co., Tennessee, 3,000', April 15, 1938, leg. Arthur Stupka; Andrew's Bald, 5,860', July 17, 1936, Great Smoky Mts. Nat. Park, Swain Co., North Carolina, July 17, 1936, leg. Siebert and Evans).
- Erora laeta* (Edwards), Small "1962" [1963], 16(3):195 (New Hampshire).
- Erora laeta*, Hessel, 1963, 17(1):43.
- Erora laeta* (Edwards) (= ♀ *clothilde* [Edwards]), dos Passos, 1964, p. 55, no. 375.
- Erora laeta*, Clench, 1966, p. 9 (Powdermill Nat. Res., Pennsylvania).
- Erora laeta* (Edwards), Clench, 1968, p. 4 (Powdermill Nat. Res., Pennsylvania).
- Erora laeta* (Edwards), dos Passos, 1970, p. 35.
- Erora laeta* (Edwards), F. M. Brown and P. A. Opler, 1970, p. 19-77, (Type in Acad. Nat. Sci. Philadelphia).
- Erora Scudder laeta* (Edwards), Riotte, 1970, p. 3.
- Erora laeta* in A. B. Klots, 1970, the rarest of Northern butterflies, newsletter Mich. Ent. Soc. 18(2):1-3.
- Erora laeta*, Patterson, 1971, 25(3):222; "on May 19, 1968 while I was walk-

ing along a grassy wood road about 8 mi SW of Wellsboro [Northern Pennsylvania], in an area much grown up to mixed hardwood brush, a fresh female *Erora laeta* literally dropped into the road in front of me. Later that same year on July 29, a worn male was collected and another sighted on blossoming hardhack [*Spiraea tomentosa*] in a nearby wet field."

Erora laeta (Edwards), Sullivan, 1971, Journ. Lep. Soc. 25(4):295 (Allegheny Co., NW corner of state while catching *Speyeria idalia*).

Erora laeta, Sullivan, 1971 *ibid.* 25(4):296 (Allegheny Co., North Carolina, July 1, 2,700' ♀, Ash Co., 2,700' ♂).

Erora laeta (Edwards), Lewis, 1973 (*partim*), p. 218, Lycaenidae pl. 18, figs. 14, 18 (Quebec to Arizona, Mexico and Central America).

Erora laeta Edwards, Brower, 1974, p. 20 (Streaked Mt., near Paris, 22 July (Smith); Dallas Plt. (Rangeley) 16 June, ♀; T2R12 (Greenville), 4 July, ♂; Orono, 18 May; Lincoln (Clayton); Bar Harbor, 19 May, ♂, 25 May, ♀ all Maine.

Erora laeta (Edwards), T. C. Emmel in Howe, 1975, p. 306, pl. 50, fig. 21 ♂ (range does not approach that of *quaderna*).

Erora laeta, Bowers, 1978 (abundance, Carroll County, nr. Bartlett, New Hampshire; habits).

Erora laeta (Edwards), Drees and Butler, 1978, p. 202 (Cabell, Greenbriar, Kanawha, Pendleton and Randolph Counties, West Virginia, V-5 to VII-26).

Erora laeta, Oosting, 1979, p. 160 (Ontonagon Co., Michigan, 27 May 1975 (one female; no *Fagus* present; *Corylus* present).

Erora laeta Miller, 1980, pp. 209–216 (general discussion and differentiation).

Taxonomic notes: The type of *Thecla laeta* Edwards (Figs. 21–22) is in the Carnegie Museum. It was discussed by Brown and Opler (1970). The type locality is London [Ontario]; the label on the type reads only "Canada." (At that time what is now called Ontario was known as "Upper Canada.")

The type of *Thecla clothilde* Edwards cannot be found in the Carnegie Museum. It was taken near Quebec by Rev. M. Provancher presumably in 1862 and probably at Cap Rouge where he lived. Provancher's collections of insects are in the College of Levis and the Quebec Public Museum, but Rev. J. C. E. Riotte who kindly examined these collections advises us (in litt.) that the type of *clothilde* is not in either of these collections. Consequently it must be deemed to have been lost or destroyed. We see no necessity to erect a neotype.

For many years the butterfly that we now call *E. quaderna sanfordi* dos

Passos was known, but classified as *E. laeta*. This has caused considerable confusion, and specimens of both were mixed together. We note that a record of "*laeta*" by Aaron (1884) from Atlantic City, New Jersey was the basis for various authors (Edwards 1884; French 1886; Scudder 1889; Maynard 1891; Holland 1898; Skinner 1898; Holland 1931; Comstock 1940; Field 1941) attributing *laeta* to New Jersey. We have always mistrusted this record, which is from an entirely wrong environment. A note from Harry Clench at the Carnegie Museum (in litt. 24 July 1978) reads: "We have a female *Erora* that is labelled Atlantic City, N.J., ex coll. Skinner, ex coll. A.N.S.P. The A.N.S.P. collection had much (all?) of E. Murray Aaron's collection, and I believe he was the source of "Atlantic City" as a locality for *laeta*. This specimen, however, is a *quaderna sanfordi*!" We believe that this Atlantic City record and any New Jersey records based on it (e.g. "Cape May") are erroneous.

Some additional records follow, based on specimens in various museums and private collections. We are indebted to J. Donald Lafontaine and A. C. Sheppard for most of these. BM = British Museum (Natural History). CNC = Canadian National Collection. LEM = Lyman Entomological Museum, McGill. UM = University of Montreal. ACS = Collection, A. C. Sheppard. PH = Collection, Peter Hall. RL = Collection, Ross Layberry.

New York. 1 ♂, Long Lake, Adirondack Forest Preserve, Upper New York State, May 22, 1977, leg. P. Hall (CNC). *New Brunswick.* Edmundston, leg. Henry Hensel, 1 ♂ June 12, 4 ♀♀ June 13–16 (BM). *Quebec.* St. Hilaire (1,500 ft) 24.V.88, 24.V.02, 24.V.10, 24.V.11, ex A. F. Winn Coll., (LEM). 1 ♀ Meach Lake, 12 mi NW Ottawa, Ont., 25.V.1968, leg. A. Hanes (CNC). 1 ♀ Duncan Lake, 7 mi WNW Wakefield, Masham Twp. 1.V.1977, leg. D. M. Wood (CNC). 1 ♂ Gatineau Park, 6 mi N. of Aylmer, 27.V.1978, leg. P. Hall (PH). 1 ♀, Gatineau Park, 29.V.1978, leg. R. Layberry (RL). Parc du Mont Tremblant, 27.V.1957, 1 ♀ and 2.VI.1958, 1 ♀, leg. A. Robert (UM). Vernet (Papineau Co.) 24.VII.1941, 1 ♀, on *Spiraea* blossom, leg. A. C. Sheppard (ACS). 1 ♂, 4 mi S. of Lost River (Argenteuil Co.) 12.V.1957, on Dandelion blossom, leg. A. C. Sheppard (ACS). *Maryland.* Dargan, Washington County, 14 April, 1977, Robert S. Simmons.

Field studies; localities: Field studies were made by the authors separately and together, and accompanied at times by others, beginning in 1934 and ending in 1968. These were at two localities; others were visited but with no results for *laeta*.

1. Near West Bridgewater, Windsor County, Vermont, up a woodroad toward Killington Peak (Rutland and Woodstock topographic quadrangles). The woodroad ascends generally westward and eventually runs into trails up Killington Peak. *E. laeta* was found along the woodroad between 1,600 and 1,900 ft altitude. This locality was first found by A. C. Frederick and

L. J. Sanford. It has been referred to by them and others, and specimens from there labelled, as "Bear Mt. near Bridgewater Corners" and "Mt. Killington" (Field, 1941, pp. 305, 315).

2. Near Sandgate, Bennington County, Vermont (Equinox topographic quadrangle). We refer to this as "Mt. Equinox," as have other collectors. From Sandgate a country road runs northeastward and eastward through a community called Beartown; and from this a woodroad ascends to the saddle (2,300 ft altitude) between Mt. Equinox and Mother Meyrick Mountain. *E. laeta* was found most commonly at this saddle, but also below it along woodroads on both sides down to about 1,900 ft altitude. This locality was first found by the veteran student of lycaenids, J. C. Cook; and A. C. Frederick also collected there. Their material was mostly labelled "Mt. Equinox, near Manchester, Vermont, 2000 ft." and was so referred to by Field, loc. cit.

We learned about these localities through the kindness of Messrs. Cook, Frederick and Sanford. During our fieldwork considerable plant-successional changes took place at both localities as old meadows and clearings were invaded by trees and shrubs and the woodroads became more shaded. In addition the woodroads at both localities were heavily bulldozed because of logging operations higher up. However, these changes did not appear to affect the *laeta* except, perhaps, to concentrate them in open spaces.

In all, the authors put in, separately or together, a total of 52 days at these localities. *E. laeta* was taken or merely seen on 16 occasions, as noted below.

- 1934, 22-23 May, Mt. Equinox, none
- 14 June, Mt. Equinox, none
- 1936, 29 May-1 June, Mt. Equinox, none
- 1938, 4 June, Mt. Equinox, none
- 5 June, W. Bridgewater, none
- 1947, 29 May, Mt. Equinox, none
- 1 June, W. Bridgewater, none
- 1949, 4 June, Mt. Equinox, none
- 5 June, W. Bridgewater, 1 ♂, 1 ♀, both worn
- 10 June, Mt. Equinox, 1 ♂, 2 ♀♀ (1 very fresh), 2 seen
- 1950, 9 June, Mt. Equinox, none
- 10 June, Mt. Equinox, none
- 11 June, W. Bridgewater, none
- 12 June, Mt. Equinox, none
- 1951, 19 May, Mt. Equinox, 1 ♀ (worn), 1 ♀ (very fresh), 1 ♂ seen
- 26 May, Mt. Equinox, 2 ♀♀ (very fresh), 1 seen
- 28 May, W. Bridgewater, none

- 5 June, Mt. Equinox, 5 ♂♂, 9 ♀♀, mostly very fresh
 20–21 June, Mt. Equinox, 1 ♀ (worn), 1 ♀ (very fresh)
 1952, 23–24 May, Mt. Equinox, none
 6 June, Mt. Equinox, none
 1953, 29 May, Mt. Equinox, none
 14–15 June, W. Bridgewater, 1 ♂ seen
 1955, 7–9 June, Mt. Equinox, none
 1956, 16 June, Mt. Equinox, none
 17–18 June, W. Bridgewater, 1 ♂, 1 ♂ seen
 1957, 9 June, W. Bridgewater, none
 10–11 June, Mt. Equinox, 20 ♂♂ and ♀♀, mostly fresh to very fresh,
 several more seen
 1960, 17–19 June, Mt. Equinox, none
 1961, 17–18 June, Mt. Equinox, 14, mostly ♀♀ and very fresh, 2 seen
 19 June, W. Bridgewater, 2 seen
 1963, 11 June, Mt. Equinox, 1 seen
 1966, 12 June, Mt. Equinox, 16 ♂♂ and ♀♀, some very fresh, others seen
 1967, 12–15 June, Mt. Equinox, none
 1968, 31 May, Mt. Equinox, none
 3 June, Mt. Equinox, none

Only days of favorable weather when *laeta* might have been flying are listed. All records are, of course, of the first generation. No consistent efforts could be made to find the second generation; on two visits to Mt. Equinox in mid-July none were seen. We found *laeta* in only 8/18 years, but suppose that it was present in all years. Only four years: 1951, 1957, 1961 and 1966 were "good." The record for 1951 at Equinox is notable, for the first specimen, a somewhat worn ♀, was taken on 19 May and a very fresh one on 21 June, a flight period of more than a month. During the first part of the flight period Shadbush *Amelanchier canadensis* (L.) comes into bloom, followed by the Wild Cherries *Prunus serotina* Ehrh. and *pensylvanica* L.

Associated butterflies: *E. laeta* appeared to be preceded in flight, at the same altitude levels, by *Celastrina ladon* (Cramer) and *Erynnis brizo* (Boisduval and LeConte) and *juvenalis* (Fabricius). A few individuals of *Pieris napi oleracea* Harris precede *laeta*, but occasional very heavy flights of this species may coincide with flights of *laeta*. *Pieris virginiensis* Edwards was taken only once (1951). Fresh *Poanes hobomok* (Harris) and *Amblyscirtes samoset* (Scudder) and *vialis* (Edwards) flew consistently with fresh *laeta*. Lower down on the woodroads fresh *Papilio glaucus* L. of the small northern form, *Boloria selene* (Denis and Schiffermueller) and *bellona* (Fabricius), *Melitaea harrisii* (Scudder) and *Phyciodes tharos* (Drury) were be-

ginning to fly and occasionally strayed up into *laeta* territory. Toward the latter part of the *laeta* flight season a phenotypically very mixed population of *Limenitis arthemis* (Drury) and *astyanax* (Fabricius) became common. We conclude that the flight period of *laeta* lasts about a month to five weeks beginning a week to ten days after the first flight of *C. ladon* and *E. brizo* and *juvenalis*.

Our studies and the observations of other collectors indicate that *laeta* populations show considerable fluctuation from year to year, with occasional years when there is almost an outburst with large numbers occurring. Opposed to this is the possibility that, since *laeta* is essentially a tree-living species, a year of apparent sudden abundance is merely one when a chance combination of circumstances brings (or keeps) a large number of individuals down at ground level for hardening the wings, drinking and basking. Very likely much of the seemingly abnormal abundance is due to the fortuitous presence of the collector at just the right time.

The two *laeta* localities are in what is essentially the Beech-Birch-Maple hardwood forest that covers large areas in the Canadian Life Zone (Merriam), Coniferous Forest Biome (Shelford) and Canadian Biotic Province (Dice). The localities contain, however, large admixtures of the Transition Life Zone, particularly in the warmer localities at lower elevations. This is in accordance with the known geographic distribution of *laeta*, since such an environment occurs far southward along the Appalachian and Allegheny mountains and highlands.

Associated plants: The chief trees and shrubs serve as an index to the environment. Some of these, such as Red Spruce (*Picea rubens* Sargent), Sugar Maple (*Acer saccharum* L.), Mountain Maple (*Acer spicatum* Lamarck), Striped Maple (*Acer pensylvanicum* L.) and White Birch (*Betula papyrifera* Marshall) are characteristic dominants of this lower Canadian Zone formation. Other important woody plants were willow (*Salix*) two species, Quaking Aspen (*Populus tremuloides* Michaux), Beaked Hazelnut (*Corylus cornuta* Marshall), Gray Birch (*Betula populifolia* Marshall), Cherry Birch (*Betula lenta* L.), Yellow Birch (*Betula lutea* Michaux), Beech (*Fagus grandifolia* Ehrhart), Gooseberry (*Ribes* sp.), Shadbush (*Amelanchier canadensis* L.), Raspberry (*Rubus idaeus* L.), Flowering Raspberry (*Rubus odoratus* L.), Blackberry (*Rubus allegheniensis* Porter), Wild Black Cherry (*Prunus serotina* Ehrhart), Wild Red Cherry (*Prunus pensylvanica* L.), Red Maple (*Acer rubrum* L.), Maple-leaved Viburnum (*Viburnum acerifolium* L.), Hobblebush (*Viburnum alnifolium* Marshall) and Common Elder (*Sambucus canadensis* L.).

The mixed Canadian-Transition zonal status of the region studied at Mt. Equinox is also indicated by other butterflies found there. *Cercyonis pegala* (Fabricius) occurred in grassy meadows about a half mile below the *laeta* area as a very mixed population. In a considerable series (taken later in the

season) specimens range all the way from the northern “*nephele*” type lacking an orange patch on the forewing to the more southern “*alope*” type with a large orange patch. We personally consider these two types, *alope* (Fabricius) and *nephele* (Kirby) to rank as subspecies. In any event, they here intergraded in a narrow tension zone. The same was true of the population of *Limenitis arthemis* (Drury) which occurred very commonly, chiefly below the restricted *laeta* area, as a very mixed population of *L. arthemis arthemis*, the northern, white-banded subspecies, and *L. arthemis astyanax* (Fabricius), the more southern, non-banded subspecies. In a large series collected here occurred almost every possible intergradation between these two phenotypes. In the West Bridgewater area a large series of *Melitaea harrisii* Scudder was taken over several years in a meadow below the *laeta* area. They show a great variation between lightly marked individuals like the southern population *liggetii* Avinoff and dark individuals like the northern *albomontana* Avinoff. We have some doubt about recognizing *liggetii* and *albomontana* as “good” geographic subspecies; there is too much intergradation all along the line between them.

Foodplant: For many years only the record of Mousely (1923) pointed to beech as the *laeta* foodplant. On Mt. Orford, Quebec, Mousley watched a *laeta* female deposit an egg on the underside of a beech leaf near the base and midrib. The egg was taken; the larva began feeding on beech, but soon died. We therefore paid special attention to beech, but never saw females on it. A number of captive females were confined on it both in sleeves in the field and in cages at home. Other potential woody foodplants were also tried, but with no luck. Most of the females were very fresh, and probably had never mated; one worn one had apparently already deposited her eggs. Then in 1951 a female laid (8–10 June) about 20 eggs on both beech and beaked hazel leaves and also the screen of the cage. The eggs hatched 14–19 June. A number of the larvae were lost, but several ate either beech or beaked hazel leaves through the first instar. After that those on beech ceased to feed. One of these, transferred to beaked hazel, ate that and survived; the other beech-eaters died. One larva on beaked hazel died in its second instar, three survived into the third instar, and two others survived to pupate. One of the pupae died, but the other survived to eclose as a rather small female on 4 August, under the care of Dr. Frederick Rindge. We afterward guessed that some of the beech leaves, which came from Pelham, New York, were polluted. (This we know to have been the case with some pine foliage from there used for other larvae.) The beaked hazel, brought from Vermont and Connecticut, was clean enough. It was noted that three of the larvae, including the one that developed into an adult, fed partly on developing hazel fruits, which is consistent with Whittaker’s record of finding a *laeta* larva on a beech fruit (see below). During later fieldwork in 1951 and subsequent years a great deal of time was spent in examining both beech

and hazel minutely, but no eggs or larvae were found on either. There was abundant beaked hazel, as well as beech, in the *laeta* areas.

In 1972 or 1973 Dr. R. H. Whittaker found a larva on beech in the Hubbard Brook Experimental Forest in the vicinity of West Thornton, 22 km north of Plymouth, Grafton County, New Hampshire. This was in the course of a Hubbard Brook ecosystem study, forest part (Whittaker, R. H. et al. 1974, Ecological Monographs, 44:233–254). Dr. Whittaker kindly sent us the following information: "We were felling trees, including beech, for detailed dimensional analysis; a part of this was the separation of sample branches into wood, twigs with leaves, and fruit. I was plucking and bagging fruits, and had tossed a fruit with larva into the bag when my mind connected two points; it was a lycaenid larva, and the larva was associated with beech and *Erora*. The larva, retrieved, was found to have been feeding on the soft papillae of the beech fruit. It continued to feed on these for a few days." The larva then died and was preserved and deposited in the Peabody Museum of Yale University. Sent to us through the kindness of Sidney Hessel, it was compared with our preserved *laeta* larvae and photographs and positively identified as *laeta*.

We sent a questionnaire to a number of collectors who had taken *laeta*. Many of these answered that there had been beech in the environment; none stated that there was no beech; fewer had noticed beaked hazel. Edward Voss kindly showed us the locality in Bliss Township, Emmet Co., Michigan where he and Wagner had collected *laeta* (Voss and Wagner 1956). Beech was present, but beaked hazel was not. The fact that our larvae were reared through on beaked hazel does not indicate that this is a normal foodplant—only that it is an acceptable substitute in vitro. Unfortunately our mention of *laeta* having been reared on beaked hazel has crept into print (via the grapevine) in Forbes, 1960, pp. 131–132. However, Oosting (1979) has recently recorded the presence of *laeta* at a locality in Ontonagon Co., Michigan where there is abundant beaked hazel but apparently no beech. So, the matter stands open; we consider beech to be the normal foodplant over at least most of the range, with beaked hazel perhaps a natural foodplant in some localities and circumstances.

Newly hatched larvae probably do a certain amount of leaf skeletonizing at first but are likely to switch to flowers and developing fruits. If they do not find any of these they may continue on leaves. As the rearings took place the following durations were noted: egg, 6–6.5 days; 1st instar, 4–5 days; 2nd instar, 4–5 days; 3rd instar, 4–4.5 days; 4th instar, 5.5 days, 5th instar, 11.5 days; pupa, 13 days.

Egg (Figs. 9–11): Pale, slightly greenish yellow, considerably flattened; height 0.30–0.34 mm, diameter 0.69–0.75 mm, with a somewhat variable, shallow depression surrounding micropyle. Micropyle of 5–6 unequal polygonal cells surrounded by many smaller ones. Surface of egg thickly stud-

ded with small, conical projections irregularly placed, basally connected by very fine, raised ridges. There are about 25 of these projections along an irregular line from base to termen; those around the base are slightly longer. Duration of egg stage (5 eggs) averaging slightly more than 6 days. Cf. Scudder 1889, Vol. III, pl. 65, fig. 8.

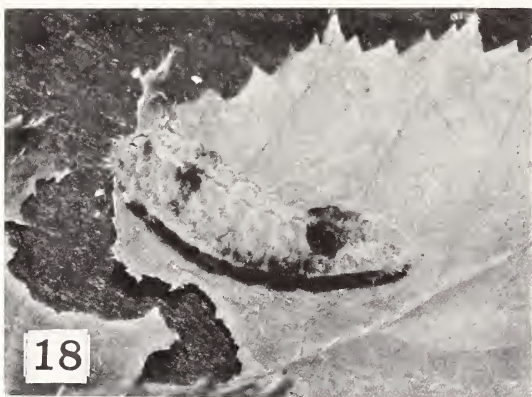
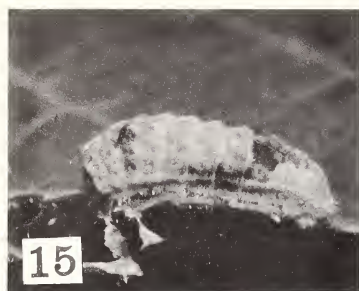
Larva, first instar (Fig. 1): Length 1.9–2.2 mm (5 larvae). Pale, greenish yellow, elongate, subcylindrical, not flattened. Head small, its connection with prothorax very lightly sclerotized. A finely reticulate area on dorsum of prothorax marking the site of the calvarium (see below) in later instars. All body segments with very long, finely spiculate setae as shown. Heavily sclerotized black lenticles as shown on prothorax, mesothorax and abdominal segments 1–7 (two each) and 8 (one). Prolegs with 4 crotchets on each side. From a preserved specimen. Average duration of instar (4 larvae) 4.5 days.

Larva, second instar (Figs. 2, 12–13): Length 2.8–4.1 mm. Pale greenish yellow with an indistinct, darker, middorsal line. Head small, almost colorless; a round dark spot at each cluster of stemmata; mandibles and bases of antennae brown. Head greatly retracted beneath prothorax. Body covered with very small, coronate chalazae, each consisting of a small, basal swelling bearing a corona of 5–9 radiating spines or teeth and a central, longer spine usually minutely spiculate and more or less curved. These chalazae are essentially colorless and almost hide the underlying skin. The slightly darker appearance of the dorsal and lateral lines is caused by the darkness of the large chalazal spines. A series of paired, slightly protuberant dorsolateral swellings on mesothorax, metathorax and abdominal segments 1–7, which bear noticeably longer central spines. Dorsal surface between these swellings slightly concave, and lateral surfaces between dorsolateral swellings and ventrolateral ridges almost flat or slightly concave. Average duration of instar (5 larvae) 4.5 days.

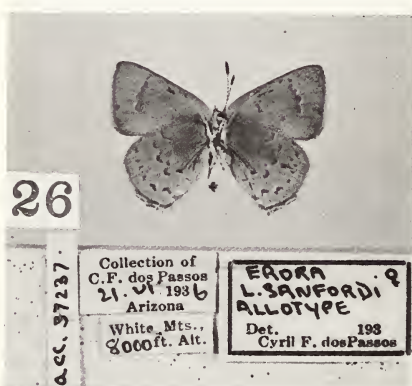
Larva, third instar (Fig. 14): Length 4.8–5.9 mm. Very much as in second instar, essentially colorless, the very dense coronate chalazae masking the skin color. Central spines of chalazae along dorsolateral swellings and ventrolateral ridges especially long. Average duration of instar (5 larvae) 4.2 days.

Larva, fourth instar: (Pressure of other work prevented the recording of a detailed description.) In this instar the larvae had developed a definite pattern of dark spots and except in size resembled the fifth instar larva described below.

Larva, fifth instar (Figs. 3–8, 15–19): Length when mature 11.5–12.3 mm. Vesture of prothorax very short and sparse in central calvarium. This is diamond-shaped, its cephalic angle very attenuate and sharp, with concave sides, its caudal angle shorter and truncate. Skin yellowish green showing more or less through vesture depending on degree of distention of larva.



Figs. 15-20. *Errora laeta*. 15-18. Mature larvae, lateral and laterodorsal views, showing normal variation. 19. Mature larva, lateral view, a lightly marked specimen. 20. Prepupal larva, dorsal view; the prothoracic calvarium shows plainly.



Figs. 21-26. 21-22. *Erora laeta* (Edwards), type ♂, upper and under sides. 23-24. *Erora laeta sanfordi* dos Passos, holotype ♂, upper and under sides. 25-26. *Erora laeta sanfordi* dos Passos, allotype ♀, upper and under sides.



Figs. 27-34. 27-28. *Erora laeta*, pupa, dorsal and lateral views. 29-30. *Erora quaderna sanfordi*, mature larva, lateral views; Chiracahua Mts., Arizona. 31-32. *E. q. sanfordi*, pupa, dorsal and lateral views. 33-34. *E. laeta* ♀♀ displaying, from life, Sandgate, Vermont.

Vesture of coronate chalazae with their central spines particularly long along ventrolateral ridges, especially on thoracic and last abdominal segments. Dorsolateral ridges each consisting of a swelling of each segment from mesothorax posterad; these give the larva a subserrate outline. The most anterior of these swellings, on the mesothorax, is especially prominent. Similar lateroventral ridges, weak on mesothorax, extending caudad to around end of abdomen. Legs and prolegs largely hidden below these. Honey gland not present.

Dark markings quite consistent in pattern but varying in color and extent. In one larva they were bright reddish; in another darker brownish red. On or about each mesothoracic swelling a small dark area. On first abdominal segment a pair of dorsolateral patches more or less running down on each side. On each side of fourth and fifth abdominal segments a patch slightly above ventrolateral ridge with traces of dark running cephalad on third, and caudad on sixth abdominal segments. On or slightly below each ventrolateral ridge a narrow dark shade on abdominal segments 1–6, diffusing out on 7. On sixth abdominal segment a pair of wide dark patches almost confluent together dorsally, extending down on each side to about the level of the spiracles, and slightly confluent with the ventrolateral patch on sixth segment, tapering caudad on seventh and eighth abdominal segments. There was some variation in the size and extent of these patches, but they were present in all of the five mature larvae studied.

Prepupal larva (Fig. 20): The general color became darker and dingier, with the dark markings less contrasty. The larva became shorter and assumed a more broad-oval shape, more rounded laterally and dorsally. The calvarium was very noticeable. No silk girdle was spun. Duration (2 larvae) 2 days.

Pupa (Figs. 27–28): Short, blunt and rounded, characteristically lycaenid. Integument more or less covered with fine, raised reticulations which, being more heavily sclerotized than the rest of the cuticula, account for the darker appearing areas. Setae arising almost entirely from chalazae at the intersections of reticulations. Setae rather sparse, there being, for example, about nine along the middorsum of the third abdominal segment, which measures 0.91 mm; setal lengths 0.10–0.21 mm. All setae simple, very finely spiculate, gradually tapering to fine tips. None of the specialized and complex sensillae present in some lycaenoid pupae (cf. Downey and Allyn 1973, many figs.) were noted. (The pupa of *E. quaderna sanfordi* had a number of “sensillae companiformia” (ibid., Fig. 62) chiefly in small clusters about the abdominal spiracles). We were also unable to find any of the small, paired pores noted by Downey and Allyn dorso-mesad of the abdominal spiracles. The stridulating structures were not studied in detail because of our reluctance to dissect the specimens. They have the caudal margin of the 5th abdominal

segment raised and more strongly sclerotized than the remainder of the segment. Entad from this is the grating surface, which is heavily sclerotized and bears many fine, uniform, parallel ridges running entad (cf. Downey and Allyn, op. cit., Fig. 24). This extends down on each side to slightly below the level of the spiracle. The file opposed to these ridges was not studied. No trace of a honey gland was found on the dorsum of segment seven. Cremasteral hooks are of the conventional form, each with a flattened, rounded tip bent strongly basad, on a low, rounded protuberance on each side of the anal slit. Each of the two pupae was formed on a leaf, but no silk girdle was seen.

Adult behavior (Figs. 33–34): A majority of other collectors' records, as well as our own, mention specimens of *laeta* as having alighted on bare ground and being seen only when they flew up, often to the collectors' surprise because their cryptic coloration made them inconspicuous. In 18/19 of our records of this the specimen was on dry earth or gravel, only one being on damp earth. Quite a number of other collectors, however, mention damp earth or mud. The late J. H. Cook described to us (in litt.) a number of *laeta* in the Mt. Equinox area flying up from a damp place where he believed there was horse urine. We tried several times to attract *laeta* in areas where they were flying by wetting the ground with water or urine, but with no success, although we did attract numbers of *Celastrina ladon*. Perhaps we should have had a horse. The majority of the specimens seen on the ground were females, and the majority of these were teneral, i.e. very recently emerged from the pupa, and emitting meconium when kept alive. They were also very tame, crawling about slowly, so that we were able to crawl up, watch them very closely and photograph them from only a few inches away. Some were making probing motions with the proboscis (perhaps only adjusting it) but others were not. We have no doubt that individuals on wet earth or mud may drink, but we did not see this. Those on dry ground seemed to be basking, sometimes orienting themselves across the line of the sun, sometimes opening the wings so as to receive a maximum of sun on the upper surface. Such an action by a female may also serve for visual attraction of a male (Figs. 33–34). The large proportion of teneral females to males probably resulted from the males having emerged earlier from the pupae and having flown to rest on foliage higher up where they were not seen.

An extraordinary experience of Bowers (1978) is highly pertinent. Mr. Bowers and Reginald Webster, collecting near Bartlett, Carroll County, New Hampshire on 21 May 1977, along abandoned dirt roads through beech woods, saw over 80 *laeta* of which all but two were females, some quite worn, while others looked freshly emerged. The females were resting on the ground, chiefly on mud, where they were presumably drinking, and are described as very easy to catch, some not even flying up when the net was

clapped over them. The day was sunny, hot (33°C) and humid, so that the *laeta* were presumably thirsty. The only two males seen flew much more actively than the females, only occasionally alighting on vegetation.

Of 27 of our specimens only 8 were caught as they rested upon or flew from the leaves of various plants. In 4/8 of these cases the leaves were of such low species as Wood Nettle (*Laportea canadensis* L.), Canada violet (*Viola canadensis* L.) and Raspberry (*Rubus idaeus* L.). In the other four cases the individuals were resting on the leaves of Mountain and Sugar Maples (*Acer spicatum* and *saccharum*) five to eight feet above the ground. One of these specimens, on a maple leaf, was caught entirely unexpectedly (in the true *laeta* tradition) when a collector made a sweep at a high-flying geometrid and found not only the moth but a scale-perfect *laeta* in his net—his first! Perhaps the individuals resting on high leaves were basking where there was more direct sunlight—a phenomenon we have noticed in some *Callophrys* (*Incisalia*) *henrici* (Grote and Robinson), which are much given to basking on the shiny leaves of Holly and Laurel.

This persistent habit of *laeta*, especially when teneral, of resting on the ground may largely explain the irregular and unexpected records of large numbers. Perhaps the adults are on the ground for only a short time when the right combination of heat, sun and thirst keeps them there. Most of the time large numbers may be present, but unseen, high in the trees. We think that the species is more a dweller in the forest canopy than has been realized.

Only once was anything like a courtship observed; a male and a female were fluttering about each other in a small, sunny spot along a shaded woodroad. After about two minutes they flew up high together and disappeared among beech foliage overhead. Perhaps most courtships and matings take place high up.

We were long puzzled by an apparent absence of flower-visiting. Captive individuals fed well on honey and sugar water. Numerous flowers such as those of Shadbush, Wild Cherries, Violet, Blackberry, Raspberry and Wintercress (*Barbarea vulgaris* Brown) were available in abundance but were not visited. Finally, on 12 June, 1966 a large number of *laeta* were seen visiting the flowers of a Wild Cherry several feet above the ground; 16 specimens were taken by W. D. Field and the junior author. Ferguson (1954, p. 197) records *laeta* in Nova Scotia visiting Blackberry flowers; Sullivan (1971) saw it on Hardhack (*Spiraea*) flowers in Pennsylvania; Covell (in litt.) records it visiting Oxeye Daisy and Wild Hydrangea in Kentucky; and Sheppard on *Spiraea* and Dandelion in Quebec. For comparison be it noted that *E. q. sanfordi* is an eager flower visitor, especially on *Amelanchier* and *Ceanothus*.

Fluctuation in numbers: Our own records, as well as those of other collectors, seem to indicate considerable variation in numbers from year to

year. Most records are of only one or two individuals; but occasionally and unexpectedly the species will be found very common or abundant. It is always possible, as noted above, that individuals are present, but unobserved, being high in the beech foliage, courting or ovipositing. We suspect that when collectors watch among high foliage they will see many more *laeta* than otherwise.

Voltinism: Our own data on voltinism are meagre. Our one reared *laeta* emerged in August. Two visits to the Mt. Equinox locality in mid-July revealed no *laeta*. Enough records are available, however, to indicate that *laeta* is bivoltine, with a second generation in July–August. Dr. Charles Covell tells us (in litt.) of over a hundred *laeta* taken on and near Big Black Mountain, alt. 4,145 ft, Harlan County, Kentucky in early to middle July, obviously second generation; only two Spring specimens have been taken, 24 April, 1976.

Distribution, summary: As discussed above, *laeta* is essentially a species of the beech-birch-maple forest that characterizes lower Canadian Zone, and of the very extensive ecotonal regions where this mixes with upper Transition Zone. In Canada it is found in Nova Scotia, New Brunswick, Quebec and Ontario, not extending northward into the Canadian Zone regions of dominant coniferous forest. In northern Michigan it flies where there are strong Canadian Zone elements, and "Great Lakes Forest." In New England it occurs in Maine, New Hampshire, Vermont and western Massachusetts, following Canadian Zone through the Green Mts. and Berkshires. It is not recorded from Connecticut or Rhode Island. We suspect, however, that it may occur in extreme western Connecticut and perhaps eastern New York where the high ridge of the Taconics runs southward from the Berkshires, carrying considerable Canadian Zone and beech, at altitudes up to 2,316 ft. Its occurrence in the Catskill Mts. is quite as expected; it must occur widely in the Adirondacks. The outlying records from the Finger Lakes region (Ithaca, Cortland, Wickwire) are in a region where some Canadian Zone elements occur on high hills, but do show that *laeta* has been able to maintain colonies that are offshoots of the main lower Canadian Zone pattern. It has not been reliably recorded from New Jersey (we regard the Aaron record from Atlantic City and Cape May as false) but it may well occur along the Kittatinny Ridge in the north. It occurs in the highlands of Pennsylvania. The single record from Maryland (Dargan, Washington County, 14 April 1977, leg. Robert S. Simmons, in litt.) is in semi-highland environment with beech present. Thence *laeta* expectedly follows the Appalachian and Allegheny highlands southward through West Virginia, Kentucky, Tennessee and North Carolina to Georgia. It may occur in the Cumberland Plateau in Tennessee and the Ozark Plateau in Missouri and Arkansas.

Erora quaderna quaderna (Hewitson)

Thecla quaderna Hewitson, 1868, p. 35.

Thecla attalion Godman and Salvin, 1887, 2:60; 3:pl.35, Figs. 19–20.

The present paper deals with *E. quaderna* only because of its relationship with *E. sanfordi* dos Passos, which we place as a subspecies of *quaderna*. The nominate subspecies occurs in central Mexico and southward. Speculations as to its phylogeny have been covered above under the genus *Erora*. Some data about *E. q. quaderna* have turned up, however, in the course of our studies and these are presented below.

Type material: The types (both unique) of *Thecla quaderna* and *T. attalion* were studied at the British Museum (Natural History) where T. G. Howarth very kindly picked them out and dissected them for us. That of *quaderna*, a female, is dissection T.G.H. 656 (1964); that of *attalion*, a male, is dissection T.G.H. 657 (1964). We compared these with specimens of *quaderna* from the United States National Museum very kindly dissected and sent on loan by W. D. Field. These were: a male, dissection W.D.T. 475 from Guatemala; and three females, dissections W.D.F. 476, 477 and 478 from Mexico and Guatemala. In coloration and pattern the specimens agreed well with the types of the corresponding sexes (making some allowance for discoloration and wear) and similarly with each other. In the genitalia we found only minor differences which seem well within the limits of individual variation. The male differed from the *attalion* type only slightly in the amount of angulation of the ventrocaudal angle of the valva. The females differed from the *quaderna* type only in minor details of the fine toothing and terminal spines of the signa. We consider these specimens and the types of *quaderna* and *attalion* to be conspecific, and *attalion* to be a junior synonym of *quaderna*.

Clench (1943, p. 223) "selected" the type locality of *quaderna* as Tancitaro, Michoacan, Mexico. We accept that designation because that locality is within the known range of the species and is one from which specimens identified with the species have been taken (Code, 72E). In addition that locality is about 365 miles from Orizaba, the type locality of *attalion* which we consider the female of *quaderna*.

We note, incidentally, that the types of *Thecla aura* Godman and Salvin (1887) a female from Irazu, Costa Rica and of *Erora gillottae* Riley (1924) a male, from Mt. Irazu, Costa Rica, were also compared with our material and with the types of *quaderna* and *attalion*, since it was believed that they might be related. They are certainly not conspecific with *quaderna* or *caudata*, and show such genitalic differences that we believe that they do not belong in *Erora*.

Environmental data: Mr. Harry K. Clench very kindly made available to

us some of his unpublished notes and observations of *E. quaderna quaderna*. These were made 5 air miles north of Zimapan, Hidalgo, Mexico, about 2,140 m altitude, 12 and 21 January 1966 by him and Lee D. Miller. In all, 16 *quaderna* were taken. The area is in a small, northward-facing valley clothed with oak-pine-juniper "chaparral" (low, open, scrubby forest). The *quaderna* were almost exclusively above 2,140 m alt. They were noted as being associated with one or more species of the small-leaved *Quercus*; and Clench (correctly, it now appears) believed that this was the most likely foodplant. These data agree well with our own from Arizona and with remarks by others. It seems reasonable to assume that this very widespread live oak-pine-juniper habitat is the home of *quaderna* wherever it occurs. This contrasts with the "cloud forest" habitat cited by Miller for *caudata*.

Erora quaderna sanfordi dos Passos, 1940

Figures 23–26, 29–32

Thecla laeta Edwards (*partim*), 1883, 3(1):8 (Ft. Grant, Cochise Co., Graham Mt., Arizona, leg. H. K. Morrison).

Thecla laeta Edwards (*partim*), 1884, p.[336] (Mt. Graham, Arizona, leg. Morrison).

Thecla laeta Edwards (= ♀ *clothilde* Edwards), Edwards (*partim*), 1884, p. 299, no. 374 (Arizona).

Thecla laeta Edwards, French (*partim*), 1886, p. 277, no. 114 (Arizona).

Erora laeta, Scudder (*partim*), 1889, 2:821, pl. 23, fig. 2 (Mt. Graham, Arizona).

Thecla laeta Edwards, Skinner (= ♀ *clothilde* Edwards) (*partim*) 1898, p. 50, no. 306 (Arizona).

Thecla laeta Edwards, Holland (*partim*), 1898, p. 249, no. (36), pl. 29, figs. 23 ♂, 24 ♂ (Mt. Graham, Arizona).

Erora laeta (Edwards), Elrod (*partim*), 1906, p. 131 (Montana and Colorado, *fide* Dyar; Arizona).

T[hecla] laeta Edwards, Coolidge (*partim*), 1910, 42(11):374 (Huachuca Mts., Cochise Co., July; Montezuma Canyon, Mt. Graham, Graham Co.; Chiricahua Mts., Arizona).

T[hecla] (Erora Scudder) laeta Edwards (*partim*) (= ♀ *clothilde* Edwards), Draudt in Seitz, "1924" [1907–1924] (1920), 5:783, pl. 155i, 1044 (1924) (Arizona).

Thecla (Erora Scudder) laeta Edwards, Holland (*partim*), 1931 p. 239, no. (55), pl. 29, figs. 23 ♂, 24 ♂ (Mt. Graham, Arizona).

Erora laeta (Edwards), Comstock (*partim*), 1940, 48(1):83 (Arizona).

Erora laeta sanfordi dos Passos, 1940, p. I (White Mts. 8,000', June 21, 1936; Santa Catalina Mts. 8,500'; Chiricahua Mts., April 7; Chiricahua,

- Arizona, July 7, 1933, leg. *ex* Sternitzky; southern Arizona, leg. Poling, *ex* J. Dahl; Mud Springs, Santa Catalina Mts., Arizona, 6,500', July 17–20, 1916; Silver City, New Mexico, leg. R. T. Kellogg).
- Erora quaderna*, Field (*partim*), 1941, 34(2):303, pl. 1, figs. 4, 5, 6, 8; pl. 2, figs. 5–8; pl. 3, figs. 11–13 (Mt. Graham, Chiricahua Mts., Prescott, Oak Creek Canyon, Santa Rita Mts., Paradise, Redington, Palmerlee, Senator, Santa Catalina Mts., Huachuca Mts., Arizona; New Mexico; Utah).
- Erora quaderna sanfordi* dos Passos, Clench, 1943, p. 223.
- Erora quaderna*, Bauer, 1954, 26(3):95–102, pl. 101 (Mingus Mt., Arizona).
- Erora Scudder laeta* Edwards *quaderna* Hewitson, Martin and Truxal, 1955, p. 23 (Arizona, March–July; California, March).
- T[hecla] laeta* Edwards, Forbes (*partim*), 1960, p. 131 (Arizona).
- Erora quaderna* Hewitson, Clench, 1961, p. 218, fig. 420 (*partim*).
- Erora laeta sanfordi* dos Passos, Roever (*partim*), 1962, 16(1):4 (Apache Co., Trout Creek Road, 7,500', July 4, 1958, 3 ♂♂, July 4, 1959 4♂♂, June 25 and 26, 1960 4♂♂, 1 ♀, July 22, 1961, 1 ♂, 3 ♀♀; Cochise Co., E. Turkey Creek Canyon, 6,400', April 10, 1959 2♂♂, 10♀♀, April 15, 1960 12♀♀; Pinery Canyon, Chiricahua Mts., April 15, 1960, 2♂♂, 4♀♀, Chiricahua Mts., April 15, 1960 4♀♀, June 19, 1960, 2♂♂; Coconino Co., Oak Creek Canyon, March 28, 1959 1♂, July 16, 1961 1♀; Gila Co., Peterson Ranch, 7,000', July 2, 1960 2♀♀; Graham Co., Wet Canyon, 6,000', April 23, 1961 2♀♀; Greenlee Co., Rte. 666, July 5, 1959 6♂♂, Gray's Peak Road Camp, July 5, 1959 5♂♂; 1♀ Pima Co., Madera Canyon, Santa Rita Mts. 4,400–4,600', March 8, 1959 1♂, March 19, 1960 3♂♂, Summerhaven, 7,800', Santa Catalina Mts., May 24, 1959 1♂, July 9, 1961 1♀; Pinal Co., Peppersauce Wash, 5,000', Santa Catalina Mts., April 18, 1961 1♀; Santa Cruz Co., Madera Canyon, Santa Rita Mts., 5,600–6,400', March 29, 1959 3♂♂, April 9, 1959 4♂♂, 28♀♀, April 10, 1959 1♂, 32♀♀, April 3, 1960 8♀♀, April 9, 1960 3♀♀, July 6, 1960 2♂♂, 7♀♀, July 9, 1960 4♀♀, July 31, 1960 2♀♀, April 6, 1961 12♀♀, Arizona).
- Erora quaderna*, Field, 1962 (Arizona).
- Erora quaderna*, (Hewitson), Hubbard 1965, Journ. Lep. Soc. 19(4), 232 (Pintos Altos Mts., New Mexico).
- Erora quaderna sanfordi* dos Passos, dos Passos, 1970, p. 35.
- Erora quaderna sanfordi* dos Passos, Emmel *in* Howe, 1975, p. 307, pl. 50, fig. 22 ♀ (Madera Canyon, Santa Cruz Co., Arizona A.M.N.H.).
- Erora quaderna* (Hewitson), Emmel and Emmel, 1973, p. 94 (doubtfully in California).
- Erora quaderna sanfordi* dos Passos, Ferris, 1976, Journ. Lep. Soc. 30(1):38–49 (Grand Co., N. Mexico, February–May). Sierra Co., July 1976. (The specimens were absolutely fresh so that it appears this species is bi-voltine. Normally collected from February to May.)

Erora quaderna sanfordi dos Passos, Miller, 1980, p. 214 (characteristics; New Mexico, Arizona, southern Utah, Mexico: Madera, Chihuahua; Loberas Summit, Sinaloa).

The citations before 1940 given above consist of references to what we now classify as *Erora quaderna sanfordi* dos Passos, known only from Utah (?), New Mexico, Arizona, northern Mexico and California (?). We regard the nominate subspecies, *E. q. quaderna*, as occurring from central Mexico southward, as noted above (under that name) and in the discussion of *Erora* phylogeny. It was known to Edwards and others of the older authors, but regarded as being merely *laeta*, so that some of their references to "*laeta*" are partly attributable to *sanfordi* when its western localities are given. It was named by dos Passos in 1940 in the combination *Erora laeta sanfordi* but since then has been variously placed as *laeta*, *quaderna* and *quaderna sanfordi*, the last combination by Clench (1943, p. 223) being in our judgment correct.

Taxonomic notes: Although Field (1941) placed *sanfordi* as a junior synonym of *quaderna* we believe it sufficiently distinct to deserve subspecific rank. For much of the following we are indebted to Harry Clench, since our own material of *q. quaderna* is scanty. On the forewings of *sanfordi* females the blue is more restricted, with only a sprinkling in the discal cell and only traces in the base of cell Cu_1 ; and in cell Cu_2 the blue extends distad to only a bit beyond the middle of the inner margin. On the forewings of nominate *quaderna* females the blue largely fills the discal cell; almost entirely fills cell Cu_1 ; and extends distad in cell Cu_2 to above about $\frac{2}{3}$ out on the inner margin. On the hindwings of *sanfordi* females, however, the blue is more extensive than in nominate *quaderna* females, especially in cell M_3 where it nearly reaches the outer margin; and the veins through this blue are more extensively lined with black. The blue of *sanfordi* is more purplish. Males of *sanfordi* have the red spots of the hindwings beneath a little smaller and duller than those of nominate *quaderna*. We have been unable to note any consistent difference in the hue of the wings beneath—not that there may not be a difference, but this green, a pigment color, seems to be rather unstable in *Erora*, fading during only a few days in flight. The same seems to be true of the color of the fringes; apart from wear these seem to fade easily from a definite red to a pale orange-red.

Field studies: Field studies of *E. quaderna sanfordi* were made 17 April–10 May, 1969, in the Chiricahua Mts. near Portal, Cochise County, Arizona, while working at the Southwestern Research Station of the American Museum of Natural History. Adults were found to be common at many places from 5,400 to 7,000 ft altitude, always in the open evergreen oak-juniper-pine scrub that covers very large areas in the lower parts of this and other Arizona mountain ranges. This represents Upper Sonoran Life Zone. The

adults were always associated with *Quercus arizonica* Sargent and *Q. Emoryi* Torrey, the dominant oaks of this habitat.

The adults were eager flower visitors, especially at *Berberis wilcoxi* Kearny, *Ceanothus integerrimus* Hook. and Arn. and *Amelanchier* in company with *Celastrina ladon cinerea* (Edwards), *Callophrys (Incisalia) augustinus annetteae* (dos Passos), *Callophrys (Mitoura) spinetorum* (Hewitson) and *siva* (Edwards) and *Erynnis juvenalis clitus* (Edwards). *Zestusa dorus* (Edwards) was also a common associate, but did not visit flowers. Its larvae were found on the same tree of *Q. Emoryi* on which a larva of *sanfordi* was found, and were reared through (Klots 1971).

When not visiting flowers the *sanfordi* adults spent much time flying about and alighting on the leaves of both the species of *Quercus*; only one individual was seen to alight on the ground, and that for only a few seconds. Even when wet soil was available the adults did not alight on it, as adults of *C. ladon* and *Z. dorus* often did. There may have been some basking on *Quercus* leaves. After a great deal of work examining *Quercus*, with the kind help of Kilian Roever (during which several *Z. dorus* larvae were found) a presumably *sanfordi* larva was found, 29 April, on *Q. Emoryi*. This was successfully reared (partly while driving to New York), pupated on 1 June and emerged as an adult *sanfordi* on 11 June. The specimen with its larval and pupal exuvia is in the American Museum of Natural History.

Mature larva (Figs. 29–30): Length with head extended forward 15 mm. Skin pale translucent green, more dilute green dorsally, showing where not covered by vesture. Head yellowish brown, darker anteriorly, paler posteriorly, darker toward mouthparts, usually almost entirely retracted beneath prothorax. Prothorax rounded, with the middorsal calvarium more or less scutelliform and somewhat depressed. Legs and prolegs pale green, yellowish toward tips. General shape onisciform, rather flattened by the lateral production of the ventrolateral ridges. Sides above these ridges slightly concave up to a pair of dorsolateral ridges along mesothorax, metathorax and abdominal segments inclusive. On mesothorax a pair of rounded protuberances at the cephalic edge, i.e. at the cephalic ends of the dorsolateral ridges; these look yellowish brown because of the concentration on them of the vesture units. Middorsal surface slightly concave between the dorsolateral ridges. Behind abdominal segment 6 the dorsolateral ridges diverge strongly to the lateral margins of the 8th abdominal segment, followed by the quite flat last segment. The ridges are most prominent at the caudal edge of each abdominal segment, giving a subserrate lateral profile. On metathorax also a pair of slightly protruding humps between the dorsolateral protrusions and the lateral margins. No dark markings; color light brown because of thick covering of brown vesture.

Most units of the vesture are, as in *E. laeta*, short coronate chalazae, i.e. each is a short chalaza with a subterminal ring of short, radiating, triangular

teeth and usually a slightly curved, stout, minutely spiculate spine terminally. Many of the pale brown vesture units have the terminal spine very short or absent. The longest terminal spines are along the ventrolateral and dorsolateral ridges. Scattered among the pale brown vesture units are a smaller number of smaller, darker, red-brown ones, not so protruding, looking like tiny red dots. No honey gland or associated structures seen. A slight silk pad was spun on a leaf, but no silk girdle was seen.

Pupa (Figs. 31–32): Exceedingly like *laeta* pupa, differing only in minor respects. Slightly more setose. Pattern of darker and lighter areas similar to, but in general slightly darker than those in *laeta* due to greater sclerotization of the raised areas and integument. A number of sensilla companioniformia (Downey and Alleyn 1973, fig. 62) were noted in small clusters about the abdominal spiracles; these were not seen in *laeta*. Stridulatory apparatus like that of *laeta*.

Voltinism: *E. q. sanfordi* is clearly bivoltine, with an early Spring generation (March, April, May) followed by a Summer one (June, July) as is shown by the records cited by dos Passos (1940), Roever (1962) and Ferris (1976).

Distribution: *E. q. sanfordi* occurs in many localities in Arizona and New Mexico. Dyar (1903, p. 40) listed it from Montana and Colorado (as *E. laeta*) and gave no other localities, East or West! Elrod (1906) merely repeated Dyar. The species cannot be credited to Montana and Colorado on this basis. Field (1941) cites a Barnes Collection specimen from Utah, leg. Bruce. This is not necessarily authentic. Similarly, a specimen in the Los Angeles County Museum from Providence Mts., San Bernardino County, California, III-22-40, leg. T. B. Blevins, is regarded by Emmel and Emmel (1973, p. 94) as mislabelled. Possibly this is the same specimen cited by Martin and Truxal (1955, p. 23) as "California, March." In any event the presence of the species in California needs verification. It is highly desirable that its extent in northern Mexico, and its southern limits there, should be investigated. Likewise, the northern extent of *E. q. quaderna*, and any possible contact between it and *E. q. sanfordi* should be investigated. Miller (1980, p. 214) gives the two localities in northern Mexico.

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